Structure and Bridge Division, VDOT **July 18, 2016**

State of Good Repair Prioritization Formula

Priority = a(**IF**) + b(**CF**) + c(D**RF**) + d(**SCF**) + e(**CEF**)

- Max = 1.0 (highest priority); Min = 0.0 (lowest priority)
- where a,b,c,d,e are weighting coefficients and ∑(a,b,c,d,e) = 1.0
- In order to provide consistency between variables with different standard deviations and means, the final scores use percentile rankings for the IF, CF and SCF. The formulas below describe the methodology for computing the raw scores for each of the variables.

1. The formula is based on the 5 unitless variables below, each of which varies from 0 to 1.00

   IF = Importance Factor - measures the relative importance of each bridge to the overall highway network
   CF = Condition Factor – measures the overall physical condition of each bridge based on the condition of each individual element
   DRF = Design Redundancy Factor - measures four important risk factors: Redundancy, Scour Susceptibility, Fatigue, and Earthquake vulnerability
   SCF = Structure Capacity Factor- measures the capacity of the structure to convey traffic, including the effects of weight restrictions, waterway adequacy, vertical clearance and deck width
   CEF = Cost-Effectiveness Factor - measures the cost-effectiveness of the required work

   The variables have no meaning unto themselves other than as indicators of relative significance. So, for example, a structure with a score of 0.62 is more significant than one with a score of 0.43 for the variable under consideration.

2. Coefficients are selected to prioritize agency goals and may be adjusted in future years as priorities change. Coefficients currently proposed for the State of Good Repair Program as of April 29, 2016 are below:

   a = 0.30 (Importance)
   b = 0.25 (Condition)
   c = 0.15 (Design Redundancy)
   d = 0.10 (Structure Capacity)
   e = 0.20 (Cost-Effectiveness)

Structure and Bridge Division, VDOT **July 18, 2016**

State of Good Repair Prioritization Formula

Descriptions of Variables

IF = Importance Factor

- IF = 0.2(**A**) + 0.1(**B**) + 0.15(C) + 0.1(**D**) + 0.25(**E**) + 0.05(**F**) + 0.05(**G**) + 0.05(**H**) + 0.05(**I**)

Each of the component variables below is unitless and varies from 0 to 1.00:

- A = ADT/lane Factor
- B = ADTT/lane Factor
- C = Annualized Growth Rate (AGR) of ADT Factor
- D = Bypass Impact Factor – *measures effects of detours*
- E = Access Impact Factor– *measures importance of bridge to nearby facilities such as schools, hospitals and fire stations*
- F = Base Highway Network Factor
- G = Strategic Highway Network Factor
- H = STAA (Surface Transportation Authorization Act) Network Factor
- I = Virginia Highway System Factor

The Importance Factor measures the relative importance of every structure to Virginia's highway network and is the subject of a paper published by the Virginia Transportation Research Council. Importance is measured independently of other factors such as condition. Closed bridges are assigned an Importance Factor of zero.

CF = Condition Factor

- CF = 1.0 – (Health Index/100)

  - Health Index = 0 to 100 measurement of condition (a value of 100 represents a bridge without defects and a value of zero represents a bridge that has reached the end of its service life). The factor provides an overall condition measurement by weighting each element's condition as a proportion of its relative value to the whole bridge. Health Index is calculated using element-level data provided during bridge safety inspections.
  - For cases where element level data are not available the Health Index is calculated using a curve correlating average general condition rating and health index. The average general condition rating is based on the ratings for the three primary bridge components (deck, superstructure, substructure).

DRF = Design Redundancy Factor

- DRF = Part A + Part B <= 1.0

  - Part A
    = 0.75 if one of Scour Critical or Fracture Critical exists
    = 0.90 if both of Scour Critical or Fracture Critical exists

- Part B
  = 0.10 if one of Seismic Critical or Fatigue Prone Details exists
  = 0.20 if both of Seismic Critical or Fatigue Prone Details exists

SCF = Structure Capacity Factor

- SCF = .40(Weight Reduction Factor) + .30(Waterway/Vertical Clearance Factor) + .30(Deck Width Factor)

  - Weight Reduction Factor (WRF) = 0 to 1.0 score measuring ability of structure to carry Fire Trucks, Ambulances, School Buses and Design Vehicles
  - Waterway/Vertical Clearance Factor = 0 to 1.0 score measuring the adequacy of vertical clearance for waterways, railways and trucks
  - Deck Width Factor = 0 to 1.0 score measuring adequacy of deck width vs need

  The Weight Reduction Factor is the subject of a forthcoming paper that will be published through the Virginia Transportation Research Council. The factor measures the ability of structures to sustain important loadings of different varieties, including freight, emergency vehicle and buses.

CEF = Cost-Effectiveness Factor

- CEF = a function of the ratio of Repair Cost (RC) to Structure Replacement Cost (SRC)

  CEF = -2(RF/SRC) +1.3, Max 1.00, Min 0.00

  Where:
  - **RF = Requested Funds:** Initial Prioritization uses repair or replacement costs (as appropriate) from Bridge Management System Recommendations. Final Scoring uses ***funding request*** submitted by locality in application.
  - **SRC = Structure Replacement Cost:** Uses Bridge Management System estimates (based on statewide replacement cost averages with escalation factors for preliminary engineering, right of way, growth, and construction inspection).

  Note:
  CEF = 1.00 for ratios of RC/SRC ≤ 0.15
  CEF = 0.00 for ratios of RC/SRC ≥ 0.65
  CEF varies linearly from 1.00 to 0.00 as ratio of RC/SRC varies from 0.15 to 0.65

Structure and Bridge Division, VDOT **July 18, 2016**
State of Good Repair Prioritization Formula

Please contact the following for any questions:

C. Todd Springer, PE
Bridge Maintenance Program Manager
Structure and Bridge Division
Phone: 804-786-7237
Email: Todd.Springer@VDOT.Virginia.gov

Adam Matteo, PE
Assistant State Structure and Bridge Engineer, Bridge Maintenance
Structure and Bridge Division
Phone: 804-786-5171
Email: Adam.Matteo@VDOT.Virginia.gov